US006619528B2

(12) **United States Patent**
Mochizuki

(10) **Patent No.: US 6,619,528 B2**
(45) **Date of Patent: Sep. 16, 2003**

(54) **CARTRIDGE FOR HOUSING STAPLES**

(75) Inventor: **Naoto Mochizuki**, Kofu (JP)

(73) Assignees: **Acco Brands, Inc.**, Lincolnshire, IL (US); **Nisca Corporation**, Yamanashi-Ken (JP)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 78 days.

(21) Appl. No.: **09/873,269**

(22) Filed: **Jun. 5, 2001**

(65) **Prior Publication Data**

US 2002/0030078 A1 Mar. 14, 2002

(30) **Foreign Application Priority Data**

Jun. 5, 2000 (JP) 2000-167135

(51) **Int. Cl.**[7] **B27F 7/38**
(52) **U.S. Cl.** **227/120**; 227/139
(58) **Field of Search** 227/131, 139, 227/120, 127

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,076,483	A	12/1991	Olesen	227/131
5,121,868	A *	6/1992	Jairam	227/123
5,230,457	A	7/1993	Hiroi et al.	227/2
5,460,314	A	10/1995	Udagawa	227/155
5,474,222	A	12/1995	Kanai et al.	227/131
5,580,066	A *	12/1996	Jairam	227/123
5,660,314	A	8/1997	Magnusson et al.	227/2
5,791,548	A	8/1998	Udagawa et al.	227/131
5,836,502	A *	11/1998	Kanai et al.	227/131
5,975,396	A *	11/1999	Manabe	227/2
6,039,230	A *	3/2000	Yagi et al.	227/120
6,135,337	A	10/2000	Harris et al.	227/131
6,371,351	B1	4/2002	Magnusson	

FOREIGN PATENT DOCUMENTS

JP	10-000578	1/1998
JP	2000-167782	6/2000

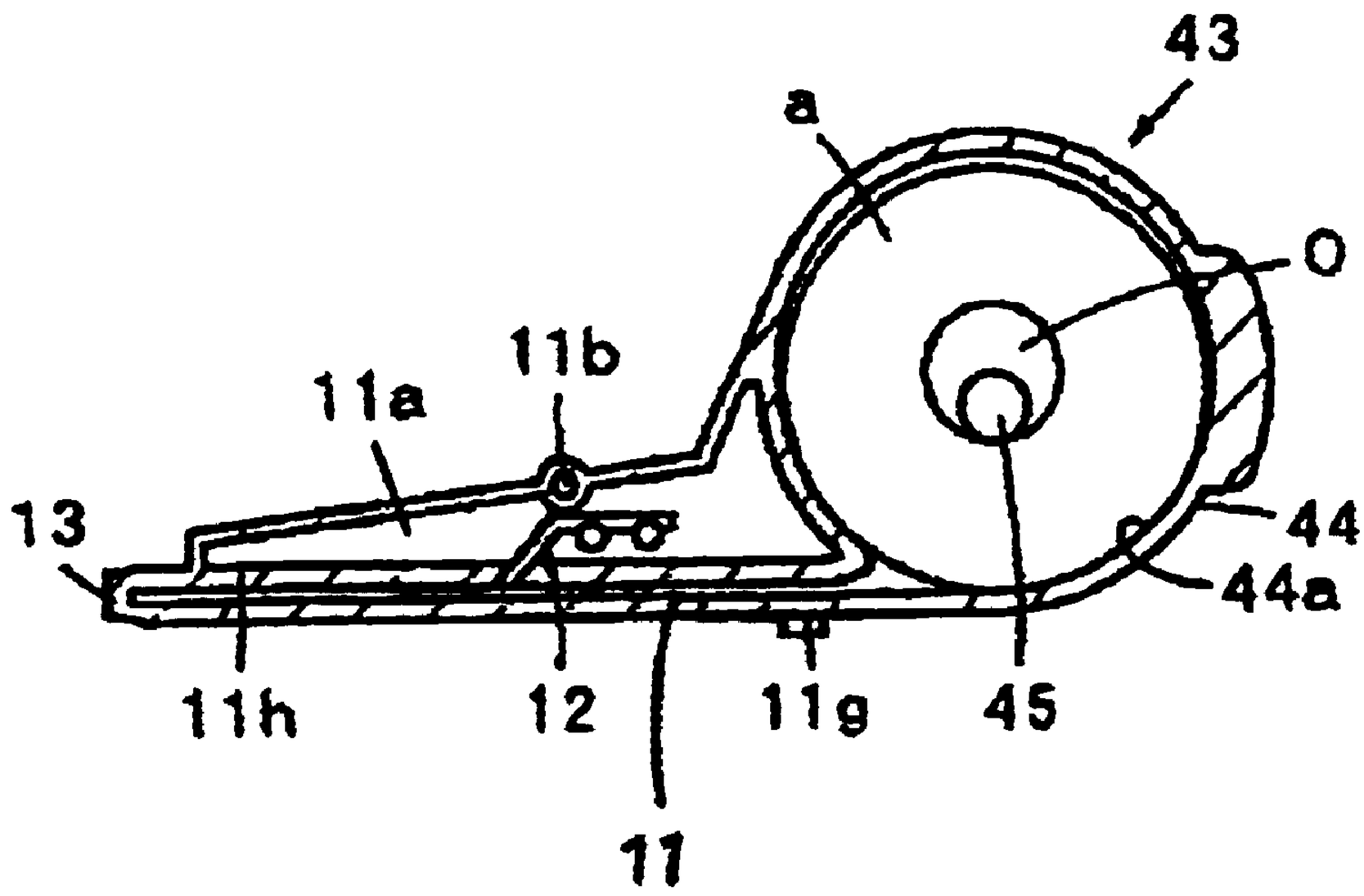
* cited by examiner

Primary Examiner—Rinaldi I. Rada
Assistant Examiner—Tara Ho
(74) *Attorney, Agent, or Firm*—Michael Best & Friedrich LLP

(57) **ABSTRACT**

A cartridge is provided that reliably feeds staples even when the sheet of staples is completely unraveled. A shaft is established in the housing unit for the cartridge as a mechanism for forming a space. The shaft is not centered inside the round housing unit but is instead off-center. In other words, the shaft is located beneath the center line of the housing unit. Also, the shaft is located completely inside the hollow cavity formed by the rolled sheet of staples. As a result, the sheet of staples does not come into contact with the interior walls of the housing unit even when the rolled sheet of staples is unraveled.

2 Claims, 7 Drawing Sheets



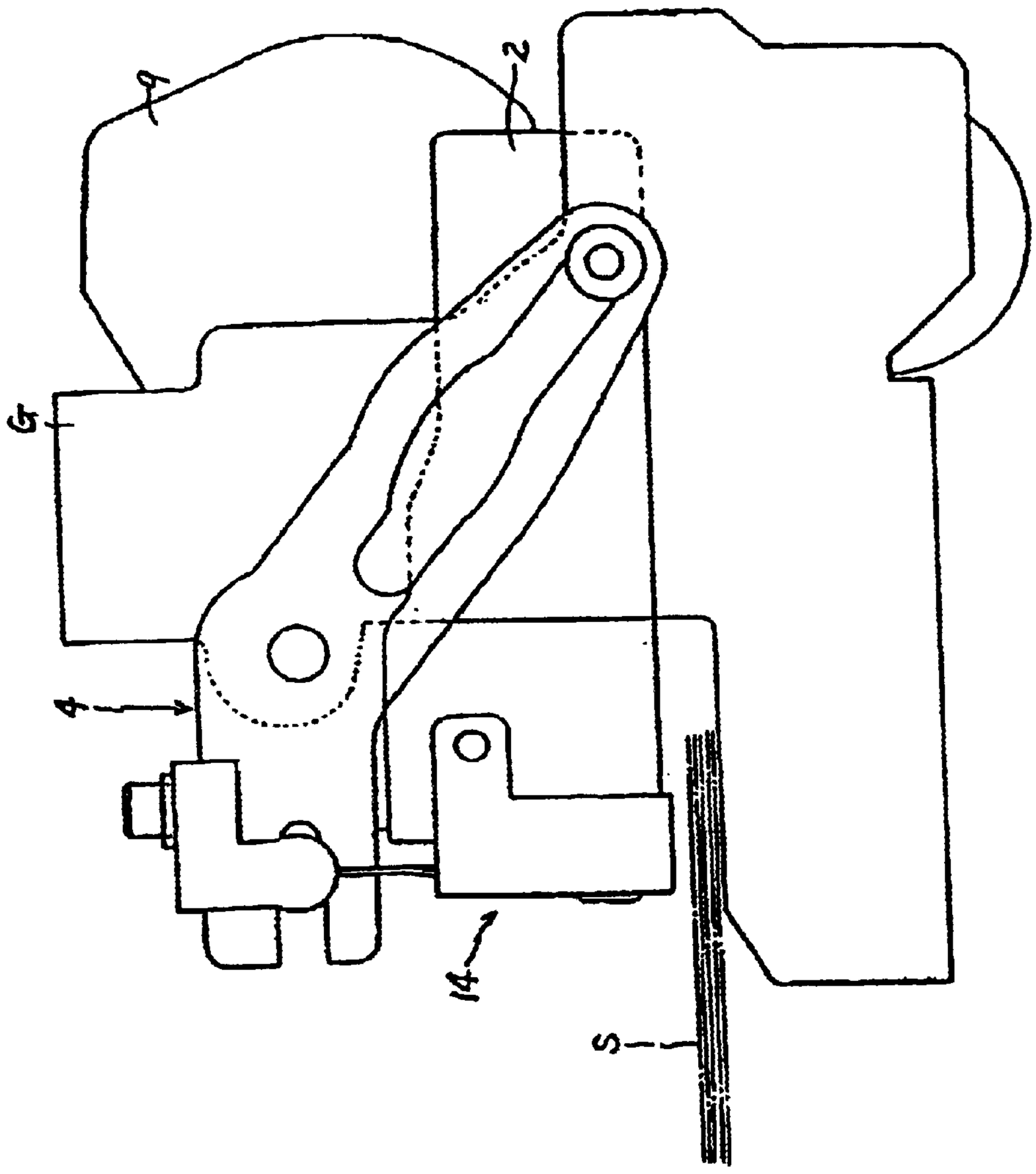


Fig. 1
PRIOR ART

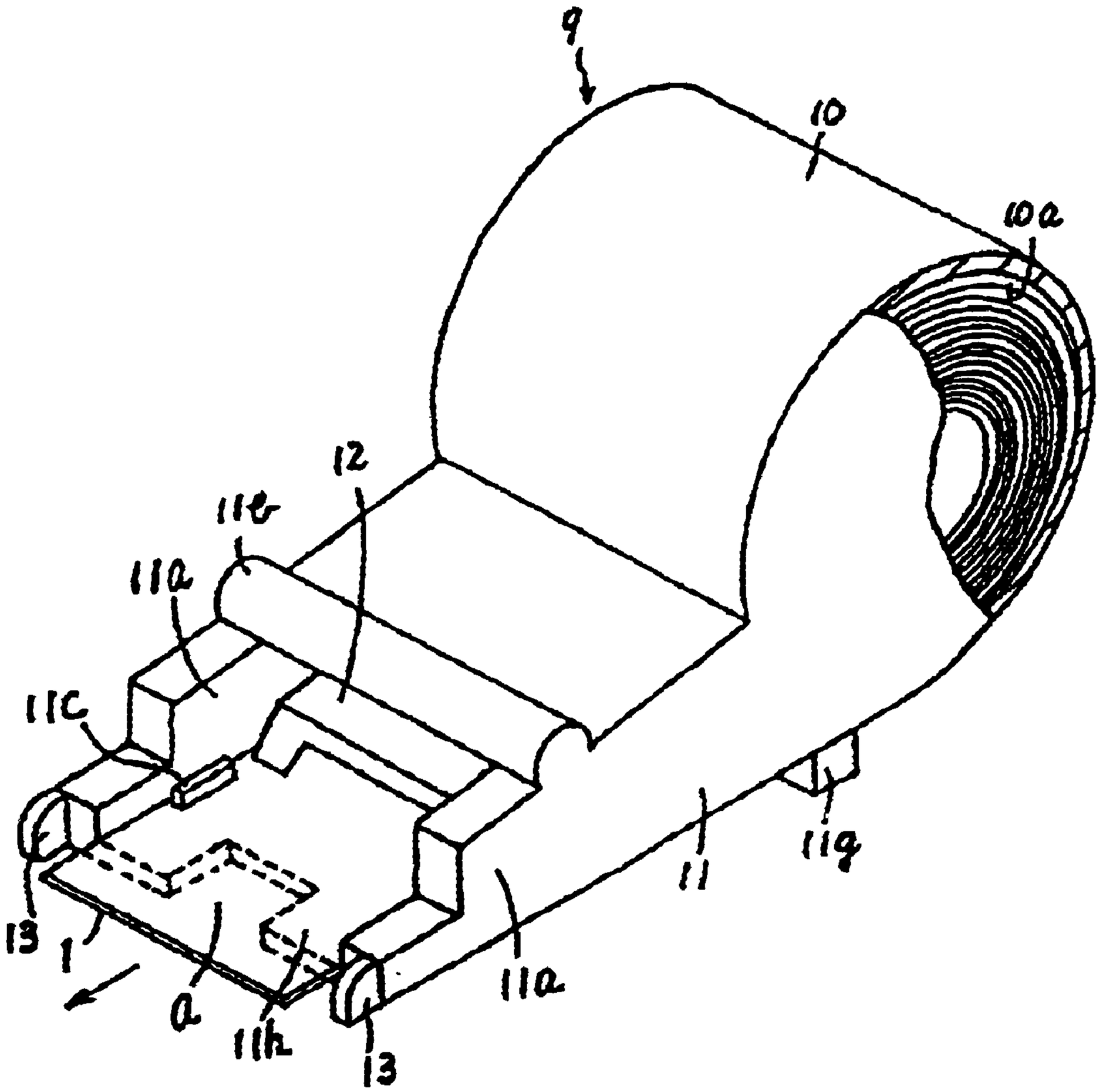


Fig. 2

PRIOR ART

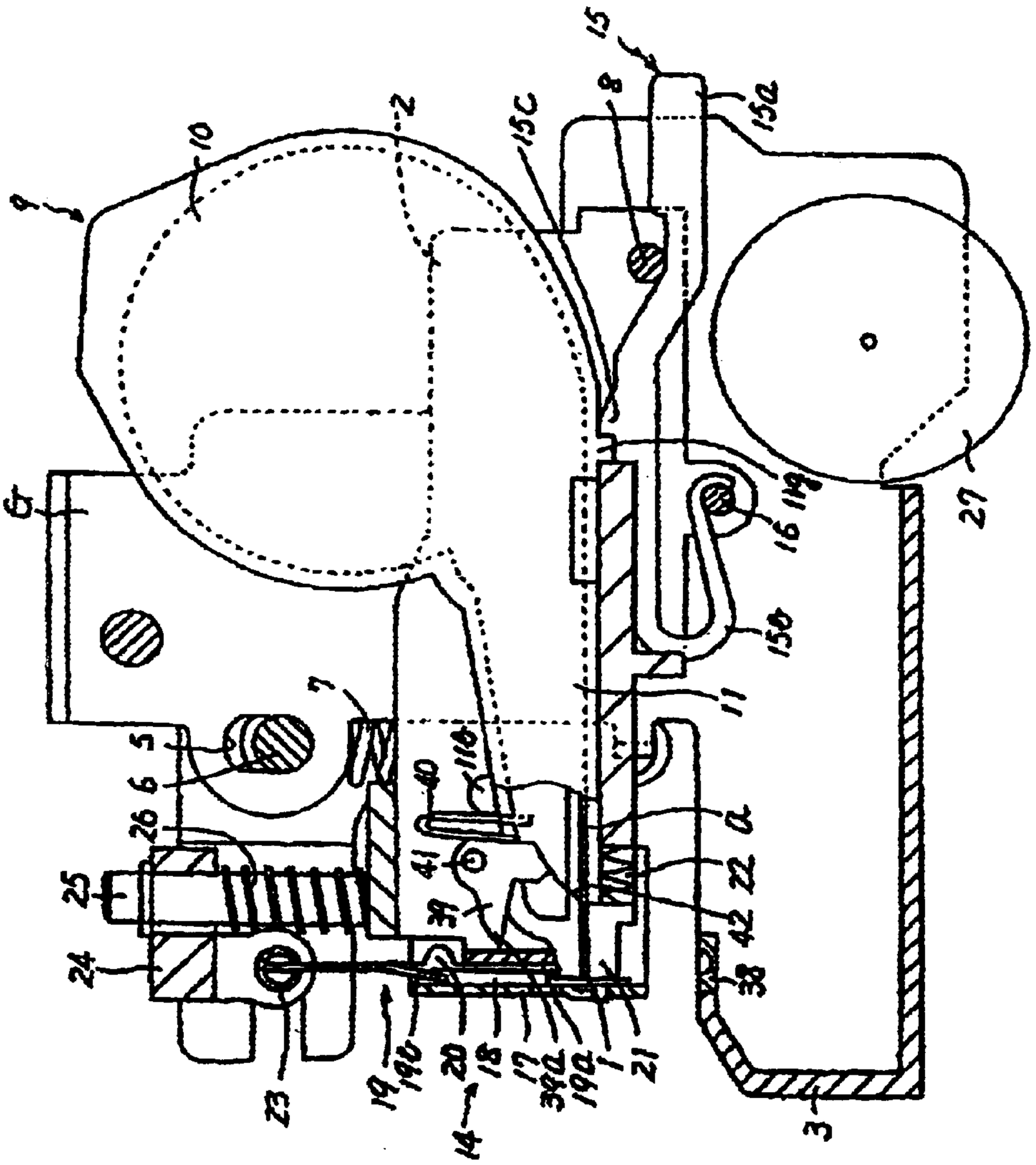


Fig. 3
PRIOR ART

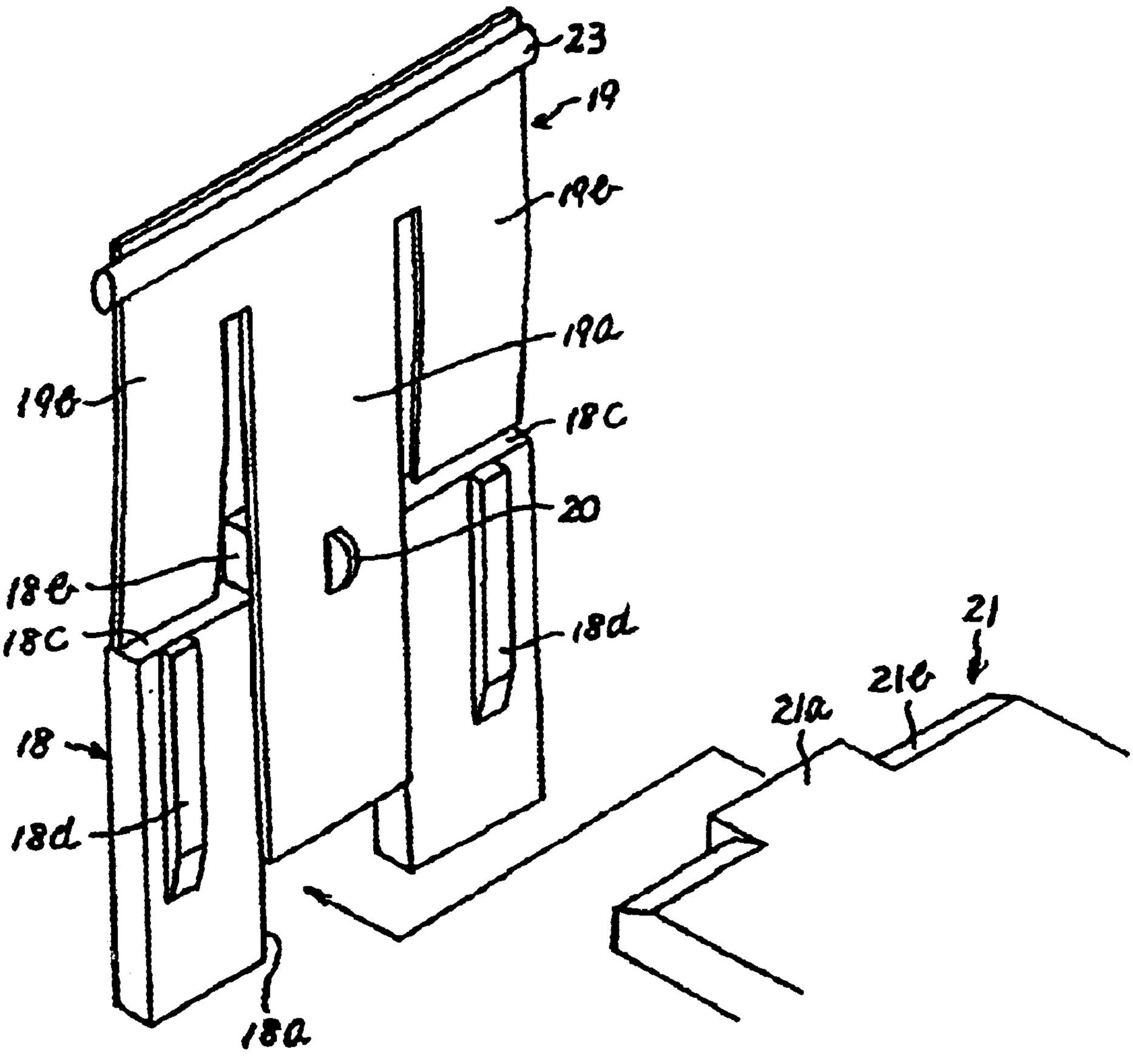


Fig. 4

PRIOR ART

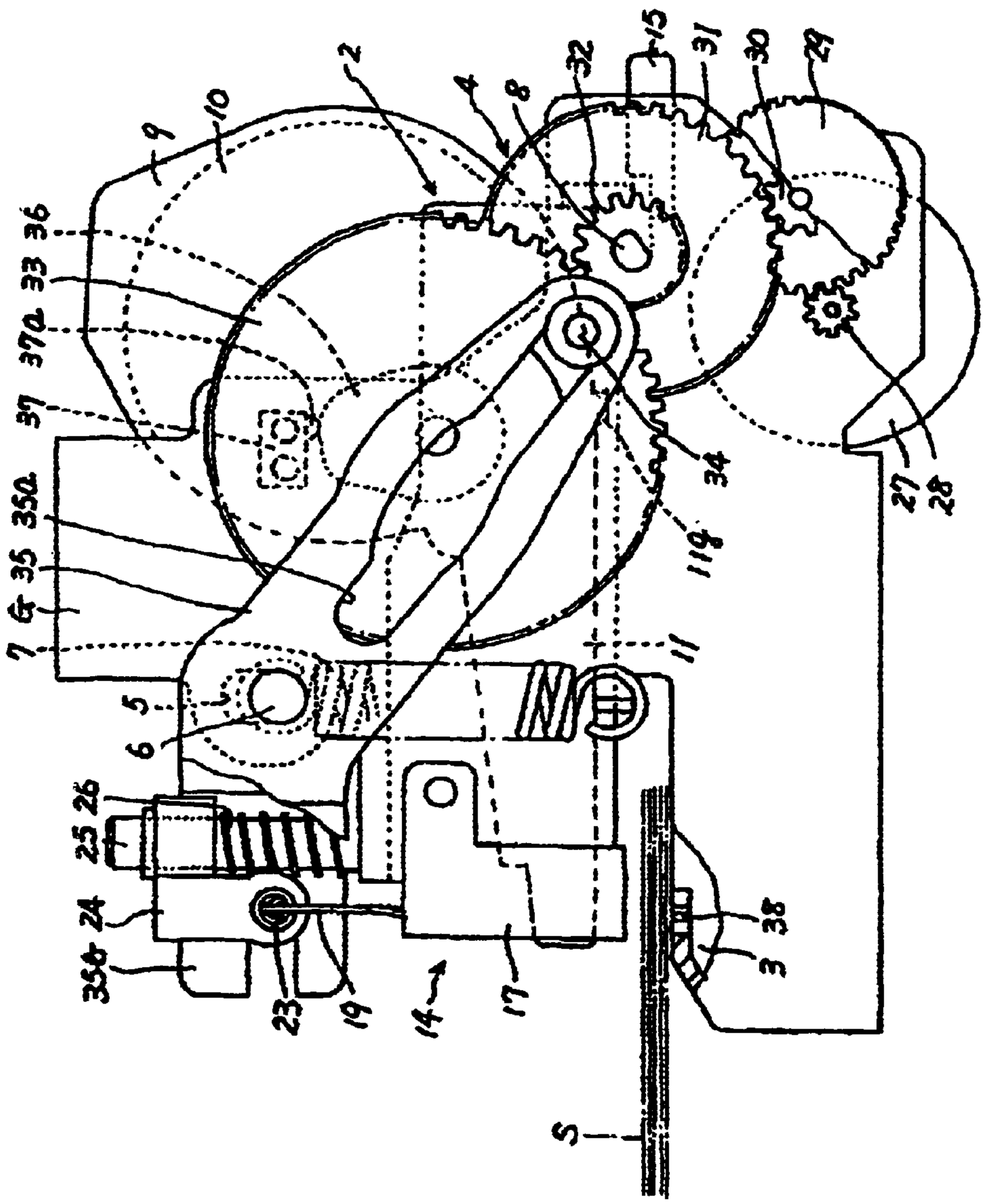


Fig. 5
PRIOR ART

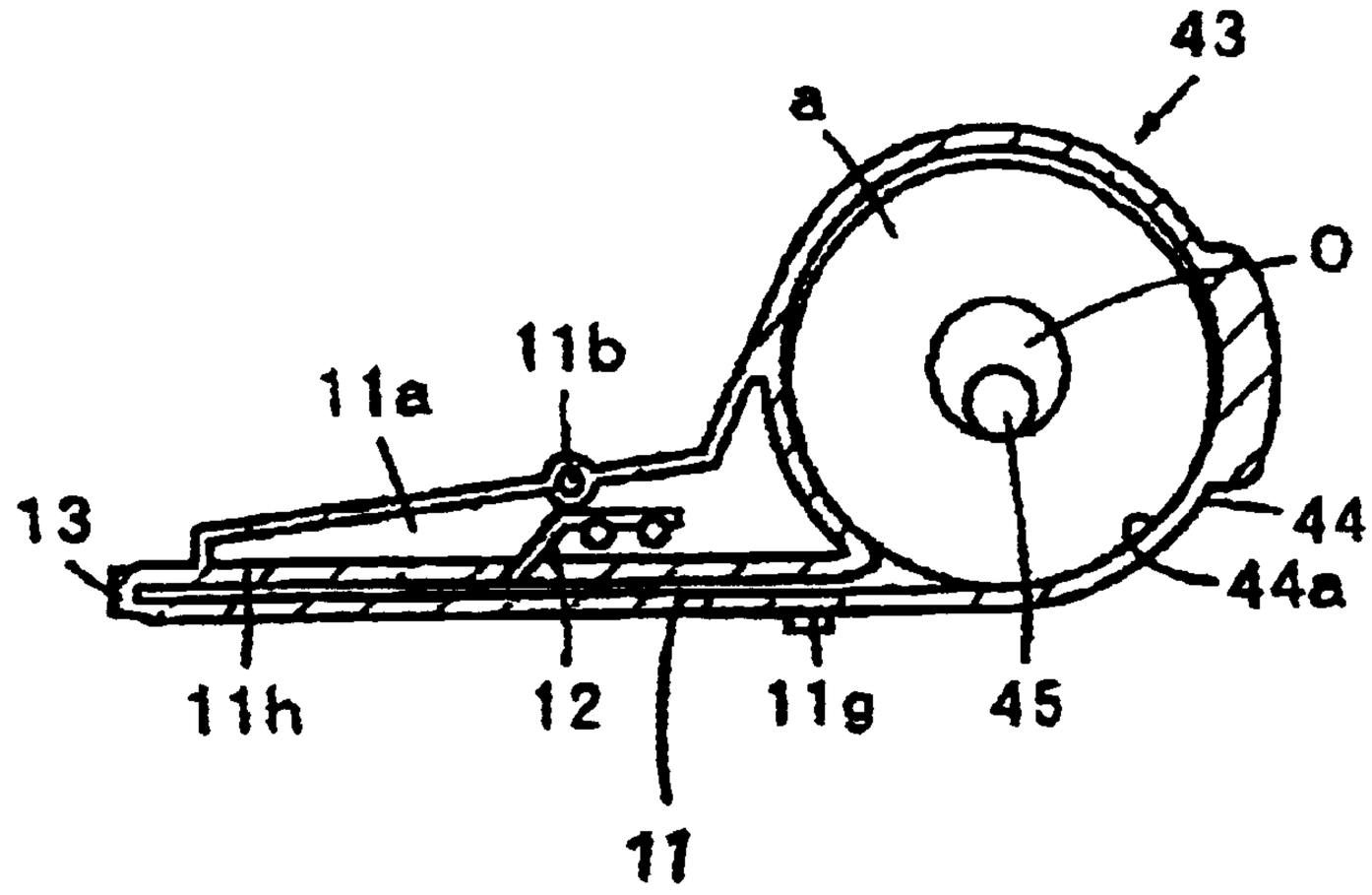

43
a
O
11b
11a
13
44
44a
11h
12
11g
45
11

Fig. 6

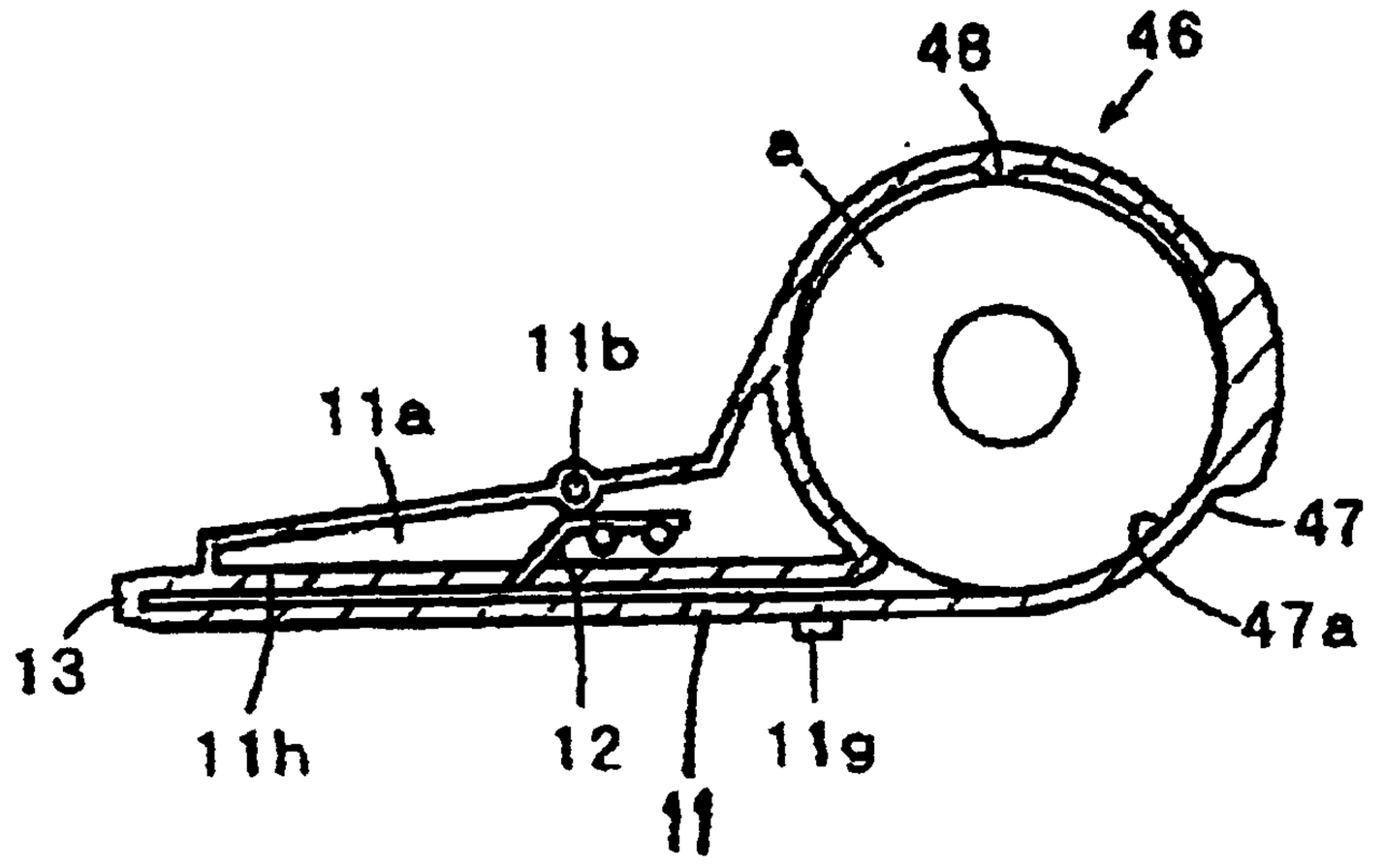

48
46
a
11b
11a
47
47a
13
11h
12
11g
11

Fig. 7

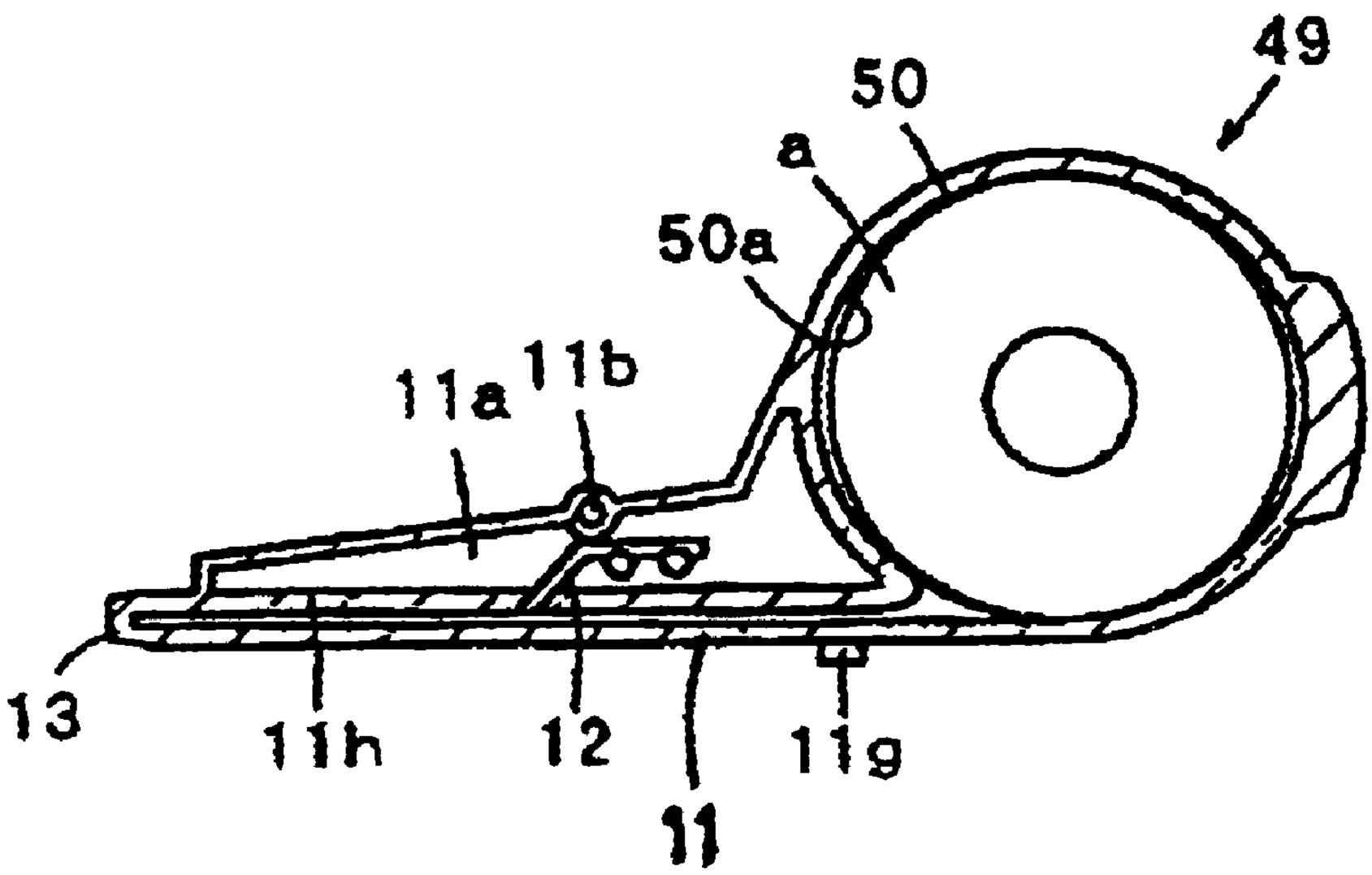


Fig. 8

CARTRIDGE FOR HOUSING STAPLES

TECHNICAL FIELD

The present invention relates to a cartridge for housing staples used to supply staples from a rolled sheet of staples to the sorter or finisher inside an image forming device such as a photocopier or printer.

BACKGROUND

The following is an explanation of the stapling operation of a prior art stapler with reference FIG. **1** through FIG. **5**. FIG. **1** is a simplified drawing of a stapler of the prior art. The main body of the stapler consists of a frame G. A mounting unit **2** and a drive mechanism **4** are installed in the frame G.

A stapling unit **14** is attached to the mounting unit **2** with an installed cartridge **9**. A stack of paper (s) is placed under the stapling unit **14** and a staple **1** is driven through the stack of paper by the stapling unit **14**.

The stapling unit **14** is moved up and down by the drive mechanism **4**, and drives staples through stacks of paper (s).

The following is an explanation of the staples **1** and the cartridge **9** housing the staples with reference to FIG. **2**. The staples **1** used to staple documents are stored in a continuous sheet of staples (a). In other words, the staples **1** are fused together in a consecutive sheet of staples (a). The staples **1** are applied one by one to documents, where they are bent into an angular C-shape and detached from the sheet of staples (a).

The sheet of staples (a) is wound in a roll and housed inside a cartridge **9**. The cartridge **9** is equipped with a housing unit **10** for housing the rolled sheet of staples (a) and a guide unit **11** for guiding the end of the rolled sheet of staples (a) from the cartridge **9**. The housing unit **10** has an outer diameter that conforms to the rolled sheet of staples (a) and a round inner periphery.

The guide unit **11** for guiding the sheet of staples (a) is equipped with a pair of walls **11***a*, **11***a* held apart at a given interval, and a protrusion **11***b*moving horizontally between the walls **11***a*, **11***a*. The protrusion **11***b* has a reverse motion stopping tab **12**. The reverse motion stopping tab **12** has a tip that makes contact with the sheet of staples (a) advancing from the guide unit **11**.

Guide grooves **11***c*, **11***c* are formed on the inside surface of the walls **11***a*, **11***a*. The guide grooves **11***c*, **11***c* support the sheet of staples (a). The interval between the guide grooves **11***a*, **11***a* has an angular C-shape and is roughly the length of a staple **1**.

A guide tab **11***c* is located in the inner surface of the walls **11***a*, **11***a*, and this guide tab **11***c* prevents the sheet of staples (a) from rising off the base **11***h* of the guide unit **11**.

The walls **11***a*, **11***a* are also equipped with tip contacting units **13**, **13** for making contact with the main body of the device when the cartridge **9** is in the device. A catch **11***g* is situated on the base **11***h* of the guide unit **11** for keeping the cartridge **9** in a certain position inside the main body of the device.

What follows is a detailed explanation of a cartridge **9** installed in the mounting unit **2** with reference to FIG. **3**. The mounting unit **2** is attached to the frame G above the base **3**. The mounting unit **2** is attached to the shaft **8** on the frame G so as to be able to rotate freely.

When the cartridge **9** is installed in the mounting unit **2**, the catch **11***g* on the cartridge **9** is drawn into the lock unit

15 formed in the mounting unit **2**. The lock unit **15** is situated on the bottom of the mounting unit **2** and has a handle unit **15***a*, an elastic U-shaped unit **15***b* formed on the tip of the handle unit **15***a*, and a protrusion **15***c* protruding towards the bottom of the mounting unit **2** from the handle unit **15***a*. The tip U-shaped unit **15***b* is hung around the pin **16** on the base **3**.

When the cartridge **9** is installed in a mounting unit **2** with a lock unit **15**, the catch **11***g* on the cartridge **9** applies pressure to the protrusion **15***c* protruding towards the bottom of the mounting unit **2**, and surmounts the protrusion **15***c*. Having surmounted the protrusion **15***c*, the cartridge **9** cannot be released because the catch **7** engages the protrusion **15***c*. In other words, the cartridge **9** cannot be extracted from the mounting unit **2** because of the lock unit **15**.

When the cartridge **9** is removed from the mounting unit **2**, the handle unit **15***a* is pressed down manually. When the handle unit **15***a* is pressed down, the end of the U-shaped unit **15***b* is pressed into the pin **16** and the U-shaped unit **15***b* is bent. The protrusion **15***c* is then released by the catch **11***g*. In other words, the handle unit **15***a* is pressed down and the cartridge **9** is removed from the mounting unit **2**.

Also, when the cartridge **9** is installed in the mounting unit **2**, the end comes into contact with the stapling unit **14**. Here, the stapling unit **14** consists of a sheath bracket **17**, a former **18** and a driver **19**.

FIG. **4** is a detailed drawing of the stapling unit **14**. A depression **18***a* is formed in the bottom the former **18**, and a protrusion **18***b* is formed in the top of the former **18**. This forms shoulders **18***c*, **18***c* on both ends.

The driver **19** has a bottom end that is divided into three plates with a long plate **19***a* in the middle and short plates **19***b*, **19***b* on the ends. A protrusion **20** is formed in the middle plate **19***a*, and this protrusion **20** makes contact with the former **18** on the opposite end.

The end of the middle plate **19***a* protrudes into the depression **18***a* in the former **18**. The plates **19***b*, **19***b* on the ends are bent into a wedge shape, and the ends come into contact with the shoulders **18***c*, **18***c* on the former **18**.

A bending block **21** is situated in the depression **18***a* of the former **18** and engages it. The bending block **21** has sloping sections **21***b*, **21***b* on both ends of the protrusion **21***a* and the protrusion **21***a* engages the depression **18***a* in the former **18**.

As shown in FIG. **3**, the bending block **21** is attached to the bottom of the mounting unit **2** via a spring **22**, which applies spring action to the left in the drawing. Push units **18***d*, **18***d* are established in the former **18** to make contact with the sloping units **21***b*, **21***b* in the bending block **21**. When the push units **18***d*, **18***d* make contact with the sloping units **21***b*, **21***b*, the spring **22** is coiled and the entire bending block **21** moves to the right in the drawing.

The top end of the driver **19** is fixed to the shaft **23**, and the shaft **23** is connected so the drive mechanism **4** can move it up and down as shown in FIG. **5**.

The front block **24** is attached to the shaft **23**, and the front block **24** is supported by the spring shaft **25** protruding from the mounting unit **2** so that it can slide. A spring **26** is placed on the spring shaft **25** so as to apply pressure to the mounting unit **2** and the front block **24**.

The mounting unit **2** is attached to the shaft **8** so it can rotate freely around the center. When the shaft **23** is raised, the front block **24** is also raised. When the shaft **23** is lowered, the mounting unit **2** is also lowered.

Therefore, when the front block **24** moves down, the mounting unit **2** moves down along the front block without

compressing the spring **26** until the mounting unit **2** makes contact with the base **3**. However, after the mounting unit **2** makes contact with the base **3**, the spring **26** is compressed and the spring shaft **25** slides as the front block **24** moves down.

The raising and lowering of the stapling unit **14** and the mounting unit **2** by the drive mechanism **4** will now be explained in detail with reference to FIG. **5**.

The drive mechanism **4** is powered by a motor **27**, and the motor **27** is attached beneath the frame G. A long hole **5** is formed upward in the frame G, and a shaft **6** passes through the long hole **5**. The shaft **6** passing through the long hole **5** is pressed downward by a spring **7** as shown in the drawing.

The motor **27** attached beneath the frame G has a shaft that protrudes outward from the frame G and the protruding end of the shaft has an attached pinion **28**.

The pinion **28** engages a relay gear **29**. The relay gear **29** is equipped with a first intermediary gear **30** having a diameter smaller than the relay gear. These two gears rotate concentrically. The relay gear **31** engages the first intermediary gear **30**.

The relay gear **31** is equipped with a second intermediary gear **32** having a diameter smaller than the relay gear. These two gears also rotate concentrically. A drive gear **33** engages the second intermediate gear **32**.

A pin **34** is located in the side of the drive gear **33**. The pin **34** is inserted into the cam ring hole **35***a* in the cam ring **35**. The cam ring **35** is supported by the shaft **6** attached to the frame G so as to be able to freely rotate. The shaft **6** is interposed, and an interposed support unit **35***b* is formed on the opposite side of the cam ring hole **35***a* to support the interposition of shaft **23**.

The drive mechanism **4** has the same configuration on the other side of the frame G (not shown). In the drive mechanism **4**, the rotation of the drive gear **33** rotates the pin **34** and shaft **6** moves the cam ring **35** up and down along the center line. In other words, the rotation of the pin **34** moves the cam ring hole **35***a* in the cam ring **35** upwards. The shaft **6** is interposed and the interposed support unit **35***b* on the opposite end is lowered. When the cam ring hole **35***a* is lowered, the interposed support unit **35***b*is raised.

A concentrically rotating cam **36** is situated on the drive gear **33**, and the cam **36** presses the position detector **37***a* on the home position switch **37** on the frame G. When the stapling operation begins, the former **18** and driver **19** are in the initial position and the stapling operation is initiated if the cam **36** is making contact with the position detector **37***a* on the home position switch **37**. If the cam **36** is not making contact with the position detector **37***a*, the motor **27** continues to rotate until contact is made. When the cam **36** makes contact with the position detector **37***a*, the stapling operation is initiated.

If the interposed support unit **35***b* is at the highest point when the cam **36** makes contact with the position detector **37***a*, the shaft **23** has also moved to the highest point.

The following is a detailed explanation of the feed mechanism for the sheet of staples (a) with reference to FIG. **3**. The stapler performing the stapling operation described above has a feed mechanism to advance the staples. The feed mechanism is at the end of the mounting unit and consists of an advancing unit **39**, a plate spring **40** and an advancing tab **42**.

When a cartridge **9** is installed in the mounting unit **2**, the protrusion **11***b* on the cartridge **9** makes contact with one end of the plate spring **40**. The other end of the plate spring **40** makes contact with the advancing unit **39**.

The advancing unit **39** is mounted on a shaft **41** connected to the mounting unit **2** so as to freely rotate. An advancing tab **42** is attached to the bottom. The end of the advancing tab **42** makes contact with the sheet of staples (a) drawn by the guide unit **11** from the cartridge **9**, and the advancing tab **42** is positioned at a shallow angle with respect to the sheet of staples (a) moving in the forward direction.

A protrusion **39***a* is formed in the advancing unit **39**. The protrusion **39***a* is positioned just beneath the driver **19** when the cartridge **9** is installed.

When the driver **19** is lowered, the protrusion **20** on the driver **19** makes contact with the protrusion **39***a* on the advancing unit **39**. This applies pressure rightward in the drawing. Under pressure, the advancing unit **39** moves to the right while bending the plate spring **40**. When the advancing unit **39** moves to the right, the advancing tab **42** also moves to the right over the sheet of staples (a). The amount of movement is equal to the width of a single staple.

When a staple **1** has been applied to a stack of paper (s) and the driver **19** is raised, the pressure on the protrusion **39***a* in the advancing unit **39** is released, and the plate spring **40** returns to its original shape.

When the plate spring **40** returns to its original shape, the advancing tab **42** which had moved to the right in the drawing then moves to the left. When the advancing tab **42** returns to its original position on the left, the tip of the advancing tab **42** engages a staple **1**. As the advancing tab **42** moves to the left, the staple also moves to the left.

In other words, the movement from the right to the left by the advancing tab **42** extracts a single staple from the housing unit **10** in the cartridge **9**. At this time, the sheet of staples (a) slides through the inner wall **10***a* of the housing unit **10**, and the sheet of staples (a) in the housing unit **10** is fed into the guide unit **11** one staple at a time. The staple at the end of the guide unit **11** on the cartridge **9** is then moved to the stapling unit **14**. The staple **1** is advanced to the stapling unit **14** as the stack of paper (s) is being stapled.

What follows is an explanation of the operation of the stapler. In a stapler with the configuration shown in FIG. **5**, a stack of paper (s) is placed on the base **3**, and a cartridge **9** is installed in the mounting unit **2**. At this time, the bending block **21** is positioned above the stack of paper (s). A staple **1** is positioned above the stack, and the former **18** and driver **19** are positioned above the staple.

Here, the cartridge **9** is installed in the mounting unit **2** and the drive mechanism **4** is operated. When the motor **27** for the drive mechanism **4** is operated, the home position switch **37** and cam **36** are positioned above the shaft **23** in the initial position. The drive mechanism **4** is then operated to lower the shaft **23** from the initial position.

When the drive mechanism **4** is operated, the gears engage and rotate. Finally, the drive gear **33** is rotated. When the drive gear **33** rotates, the pin **34** also rotates. The rotation of the pin **34** rotates the cam ring **35** around the shaft **6** and lowers the interposed support unit **35***b*. When the interposed support unit **35***b* is lowered, the shaft **23** it supports is also lowered.

When the shaft **23** is lowered, the driver **19** it supports is lowered. When the driver **19** is lowered as shown in FIG. **4**, the plates **19***b*, **19***b* on both ends press down on the shoulders **18***c*, **18***c* of the former **18**, and the entire former **18** is pressed down. The long plate **19***a* in the driver **19** is inserted into the depression **18***a* of the former **18**.

The lowering of the shaft **23** also lowers the front block **24**. The front block **24** lowers the mounting unit **2** via the

spring **7**. The mounting unit **2** is lowered while maintaining a set distance from the front block **24** and not compressing the spring **7** until the bottom makes contact with the base **11**.

When the cam ring **35** is rotated and the shaft **23** is lowered, the bending block **21** engages the depression **18***a* in the former **18**.

Here, the staple **1** at the end of the sheet of staples (a) is positioned between the former **18** and the bending block **21**. Therefore, when the depression **18***a* in the former **18** engages the bending block **21**, the staple **1** is interposed between them. The staple **1** interposed between the former **18** and the bending block **21** is then bent into an angular C-shape by the depression **18***a* in the former **18**.

When the cam ring **35** is rotated and the shaft **23** is lowered, the mounting unit **2** is also lowered and the mounting unit **2** is brought into contact with the base **3**. Even when the mounting unit **2** is brought into contact with the base **3**, the cam ring **35** is rotated and the shaft **23** lowered. The shaft **23** is lowered as the spring **26** is compressed by the front block **24**.

When the shaft **23** is lowered as the spring **26** is compressed, the driver **19** is also lowered and the former **18** is pressed downward. When the former **18** is lowered, the push units **18***d* on both ends of the former **18** make contact with the sloping sections **21***a* on the bending block **21**. When the push units **18***d* make contact with the sloping sections **21***a*, the former **18** compresses the spring **22** pressed against the bending block **21**, and the bending block **21** is pushed to the right in the drawing. The pushed bending block **21** then retreats from beneath the angular C-shaped staple **1**.

When the cam ring **35** is rotated, the driver **19** drives both ends of the angular C-shaped staple **1** through the stack of paper (s), and the staple **1** is detached from the sheet of staples (a).

The stack of paper (s) on the base **2** then forms a document **38**, and the document **38** is stapled together by pushing the ends of the bent staple **1** through the sheets of paper. After the bent staple **1** has been pushed through the stack of paper (s), the ends of the staple **1** are folded inward. Once the staple **1** has been pushed through the stack of paper (s) and the ends have been folded inward, the stack of paper (s) is stapled.

When the cam ring **35** is rotated, the shaft **23** gradually rises. The shaft **23** rises to the top position and returns to its original position. A single rotation of the cam ring **35**, in other words, brings the stapling operation to an end.

In the stapling operation, a staple is pushed through a stack of paper (s) as the feed mechanism feeds the device the next staple **1** to be applied. The next staple is positioned in the stapling unit **14** of the mounting unit **2**.

The staple feed mechanism sends staples **1** one by one to the stapling unit **14**. However, the feed mechanism rotates the rolled sheet of staples inside the housing unit **10** as the staples **1** are issued. As the rolled sheet of staples rotates, it expands.

Also, when a staple **1** becomes jammed, the cartridge **9** has to be removed. When the cartridge **9** is removed, the cartridge **9** is shaken. When the cartridge **9** is shaken, the rolled sheet of staples (a) moves up and down and left and right inside the cartridge **9**.

When the rolled sheet of staples (a) moves inside the cartridge **9**, the edge of the roll collides with the inside wall **10***a* of the housing unit **10** in the cartridge **9**, and the impact expands the rolled sheet of staples (a).

When the rolled sheet of staples (a) expands, it expands concentrically. The rolled sheet of staples (a) expands but maintains a round shape.

When the rolled sheet of staples (a) expands, the sheet of staples (a) comes into contact with the inner wall **10***a* of the housing unit **10** of the cartridge **9**. Because the inner wall **10***a* of the housing unit is round, the outer edge of the expanded rolled sheet of staples (a) comes into contact with the inner wall **10***a*. When the outer edge of the expanded rolled sheet of staples (a) comes into contact with the inner wall **10***a*, the contact area is increased. When the contact area between the sheet of staples (a) and the inner wall **10***a* is increased, the amount of friction between the sheet of staples (a) and the inner wall **10***a* also increases.

The unraveled sheet of staples (a) also exerts pressure. The sheet of staples (a), in other words, applies pressure on the inner wall **10***a*. The pressure on the inner wall increases the amount of friction further. When the amount of friction between the sheet of staples (a) and the inner wall **10***a* is increased, the sheet of staples (a) has difficulty sliding along the inner wall **10***a*.

The force used by the feed mechanism to feed the sheet of staples (a) largely depends on the feeding conditions. When the amount of friction between the sheet of staples (a) and the inner wall **10***a* is increased, the feed mechanism may have difficulty supplying the sheet of staples (a) and a feeding error could occur.

Therefore, there remains a need for an invention that reliably feeds staples even when the sheet of staples (a) is completely unraveled.

SUMMARY OF THE INVENTION

One embodiment of the invention relates to a cartridge for housing staples having a housing unit for housing a rolled sheet of staples and a guide unit for supporting the sheet of staples drawn from the housing unit, where the cartridge for housing staples is equipped with a space forming mechanism for forming a space between the rolled sheet of staples housed in the housing unit and the interior walls of the housing unit. The rolled sheet of staples may supported along a short axis of the housing unit.

Another embodiment relates to a cartridge for housing staples, where the rolled sheet of staples forms a hollow cavity centered on the roll and the space forming mechanism has a shaft off-center from the center line of the housing unit, and the shaft supports the hollow cavity of the rolled sheet of staples. The shaft may be off-center to a degree about the distance between a bottom of the inner wall of the housing unit and the shaft. Also the shaft may be off-center beneath a center line of the housing unit.

In the cartridge for housing staples of another embodiment, the space forming mechanism is a protrusion on the interior walls of the housing unit, and the rolled sheet of staples comes into contact with the protrusion.

In the cartridge for housing staples of yet another embodiment, the space forming mechanism is an oval shaped, triangular shape or rectangular shaped inner diameter of the housing unit.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a simplified drawing of a stapler of the prior art;

FIG. **2** is a perspective view of a cartridge **9** of the prior art;

FIG. **3** is a detailed cross-sectional view of the stapler in FIG. **1**;

FIG. **4** is an enlarged view of the staple bending unit of the prior art;

FIG. **5** is a detailed external view of the stapler in FIG. **1**;

FIG. **6** is a drawing of the cartridge of a first embodiment of the present invention;

FIG. **7** is a drawing of the cartridge of a second embodiment of the present invention; and

FIG. **8** is a drawing of the cartridge of a third embodiment of the present invention;

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

In one embodiment of the present invention shown in FIG. **6**, the space forming mechanism is a shaft **45** in the housing unit **44** of the cartridge **43**. In this embodiment, the shaft **45** is attached to the inner wall **44***a* of the housing unit **44** in the cartridge **43**. The shaft **45** is not centered on the round housing unit **44** but is instead off-center. In other words, the shaft **45** is lower than the center line of the housing unit **44**.

The degree to which the shaft **45** is off-center is equivalent to the distance between the bottom of the inner wall **44***a* of the housing unit **44** and the shaft **45** allowing the rolled sheet of staples (a) to pass through.

The center of the rolled sheet of staples (a) is inserted in the shaft **45**. When the sheet of staples (a) is rolled, a round hollow cavity O is formed in the center. This hollow cavity O is inserted in the shaft **45**. The shaft **45** inside the hollow cavity O of the rolled sheet of staples (a) provides support to the rolled sheet of staples (a) between the shaft **45** and the inner wall **44***a*.

When the rolled sheet of staples (a) is housed in the housing unit **44** of the cartridge **43**, the sheet of staples (a) is supported between the shaft **45** and the bottom of the inner wall **44***a*. When the rolled sheet of staples (a) is supported in this way, it cannot move around inside the housing unit **44**.

When the rolled sheet of staples (a) cannot move around, it cannot become unraveled. As a result, the sheet of staples (a) does not come into contact with the inner wall **44***a* of the housing unit **44**, and staple feeding errors are prevented.

When staples **1** are used, the sheet of staples (a) is kept small inside the housing unit **44**. When the sheet of staples (a) is kept small, the roll supported between the inner wall **44***a* and the shaft **45** is kept small. As a result, the rolled sheet of staples (a) does not move around inside the housing unit **44**.

However, if the rolled sheet of staples (a) is shaken and the sheet of staples (a) begins to expand, the inner wall **44***a* and the shaft **45** limit the amount of expansion.

Because the rolled sheet of staples (a) expands concentrically, the expanded sheet of staples (a) comes into contact with the bottom of the inner wall **44***a*. When the expanded sheet of staples (a) comes into contact with the bottom of the inner wall **44***a*, further expansion downward is prevented. When the further expansion of the sheet of staples (a) is prevented on the bottom by the inner wall **44***a*, the sheet of staples (a) expands upward concentrically. However, while the sheet of staples (a) expands upward towards the inner wall **44***a*, it does not come into contact with the top of the inner wall **44***a*.

Because the sheet of staples (a) does not come into contact with the entire inner wall **44***a* of the housing unit **44** of the cartridge **43**, the contact area is reduced. As a result, the amount of friction between the sheet of staples (a) and the inner wall **44***a* is reduced, and the sheet of staples (a) is able to slide along the inner wall **44***a* very easily.

Because the rolled sheet of staples (a) is kept small and the movement of the roll inside the housing unit **44** is minimized, the recoil is also reduced. As a result, the inner wall **44***a* is subjected to less force and the amount of friction between the sheet of staples (a) and the inner wall **44***a* is not increased. Because the friction is not increased, the sheet of staples (a) does not have difficulty sliding along the inner wall **44***a*. Therefore, the invention allows for reliable stapling without staple feeding errors.

The shaft **45** is off-center beneath the center line of the housing unit **44**. However, the present invention is not restricted to this arrangement. The shaft **45** can be placed elsewhere so long as the degree to which the shaft **45** is off-center is equivalent to the distance between the bottom of the inner wall **44***a* of the housing unit **44** and the shaft **45** allowing the rolled sheet of staples (a) to pass through.

However, because the force of gravity lowers the sheet of staples (a), it makes sense for the shaft **45** to be located below the center line of the housing unit **44**.

In the another of the present invention shown in FIG. **7**, the outside surface of the rolled sheet of staples (a) does not come into contact with the entire inner wall of the housing unit. Here, the space forming mechanism is a protrusion **48** on the inner wall of the housing unit **47** of the cartridge **46**. With the exception of the protrusion **48**, this embodiment is identical to the first embodiment. A detailed explanation of the components identical to those of the first embodiment has been omitted.

In the second embodiment, the protrusion **48** is on the top of the inner wall **47***a* of the housing unit **47** in the drawing. When the rolled sheet of staples (a) is housed in the housing unit **47**, the protrusion **48** on the inner wall **47***a* and the bottom of the inner wall **47***a* support the sheet of staples (a). When the rolled sheet of staples (a) is supported by the protrusion **48** on the inner wall **47***a* and the bottom of the inner wall **47***a*, the rolled sheet of staples (a) has difficulty moving around inside the housing unit **47**. When the sheet of staples (a) has difficulty moving around, the roll has difficulty expanding.

Even if the rolled sheet of staples (a) moves around inside the housing unit **47** and the sheet of staples (a) expands, the expanded sheet of staples (a) comes into contact with the protrusion **48**. As shown in the drawing, the sheet of staples (a) expands to make contact with the inner wall **47***a*. However, the rolled sheet of staples (a) makes contact with the protrusion **48** beneath the inner wall **47***a* and does not make contact with the area surrounding the protrusion **48**. As a result, the expanded sheet of staples (a) does not make contact with the entire inner wall **47***a* of the housing unit **47**.

Because the contact area between the rolled sheet of staples (a) and the inner wall **47***a* is reduced, the amount of friction is also reduced. As a result, the sheet of staples (a) is able to slide along the inner wall **47***a* of the housing unit **47** very easily, and feed errors are prevented.

In the second embodiment, the protrusion **48** is formed on the inner wall **47***a* of the housing unit **47** near the top of the drawing. However, it can be placed anywhere on the inner wall **47** so long as the placement reduces the contact area between the sheet of staples (a) and the inner wall **47***a* of the housing unit **47**.

In a third embodiment of the present invention shown in FIG. **8**, the space forming mechanism is an oval shaped housing unit **50** inside the cartridge **49**. With the exception of the oval-shaped housing unit **50**, the embodiment is identical to the first embodiment. A detailed explanation of the components identical to those of the first embodiment has been omitted.

In the third embodiment, the housing unit **50** inside the cartridge **49** is oval shaped widthwise and the inner wall **50***a*

is oval shape. A rolled sheet of staples (a) is housed inside the oval-shaped housing unit **50**.

As shown in FIG. **8**, when a rolled sheet of staples (a) is housed inside the oval-shaped housing unit **50**, the upper end and the lower end of the oval-shaped housing unit **50** support the sheet of staples (a). Because the sheet of staples (a) is supported on these two places, the rolled sheet of staples (a) has difficulty moving around inside the housing unit **50**. When the sheet of staples (a) has difficulty moving around inside the housing unit **50**, the rolled sheet of staples (a) has difficulty expanding.

Even if the rolled sheet of staples (a) moves around inside the housing unit **50** and the sheet of staples (a) expands, the sheet of staples (a) expands concentrically. Because the rolled sheet of staples (a) is supported along the short axis of the oval-shaped housing unit **50**, it cannot make contact with the housing unit **50** along the long axis. As a result, the expanded sheet of staples (a) does not make contact with the entire inner wall **50***a* of the housing unit **50**.

Because the contact area between the rolled sheet of staples (a) and the inner wall **50***a* is reduced, the amount of friction is also reduced. As a result, the sheet of staples (a) is able to slide along the inner wall **50***a* of the housing unit **50** very easily, and feed errors are prevented.

In the third embodiment, the housing unit **50** is oval shaped. However, the rolled sheet of staples (a) can be supported at many points on the inside of the housing unit. In other words, the inner wall **50***a* of the housing unit **50** can have a different shape in order to provide support to the rolled sheet of staples (a) at many different points. This would still reduce the contact area between the rolled sheet of staples (a) and the inner wall **50***a* of the housing unit **50**. As a result, the housing unit **50** can be shaped like an oval, but also like a rectangle or triangle.

In the first, second and third embodiments, the space forming mechanism prevents the outside surface of the rolled sheet of staples housed inside the housing unit from coming into contact with the inside surface of the housing unit. As a result, the rolled sheet of staples cannot make contact with the entire inside surface of the housing unit. The reduction in the contact area between the rolled sheet of staples and the inside surface of the housing unit reduces the amount of friction and recoiling force. Therefore, the sheet of staples is able to slide along the inner wall of the housing unit very easily, and feed errors are prevented.

It should be understood that variations and modifications within the spirit and scope of the invention may occur to those skilled in the art to which the invention pertains. Accordingly, all expedient modifications readily attainable by one versed in the art from the disclosure set forth herein that are within the scope and spirit of the present invention are to be included as further embodiments of the present invention. The scope of the present invention accordingly is to be defined as set forth in the appended claims.

What is claimed:

1. A cartridge housing a rolled sheet of staples, the cartridge comprising:

a rolled sheet of staples;

a housing unit for housing the rolled sheet of staples;

a guide unit for supporting the sheet of staples drawn from an opening in the housing unit; and

a space forming mechanism for forming a space between the rolled sheet of staples housed in the housing unit and an inner wall of the housing unit;

wherein the sheet of staples forms a hollow cavity in a center of the rolled sheet of staples and the space forming mechanism is a shaft off-center from a center line of the housing unit and extending at least partially through the hollow cavity in the sheet of staples.

2. The cartridge of claim **1**, wherein the shaft is off-center beneath the center line of the housing unit.

* * * * *